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Part IV

Environmental Protection Agency

1981 and 1982 Model Year Light-Duty Diesel Vehicles: Revised Motor Vehicle Exhaust Emission Standards for Oxides of Nitrogen; 1981–1985 Model Year Light-Duty Diesel Motor Vehicles: Applications for Waiver of Oxides of Nitrogen Emission Standard

ENVIRONMENTAL PROTECTION AGENCY

40 CFR Part 86

[FRL 1496-3]

Revised Motor Vehicle Exhaust Emission Standards for Oxides of Nitrogen (NO_x) for 1981 and 1982 Model Year Light-Duty Diesel Vehicles

AGENCY: Environmental Protection Agency.

ACTION: Final rule.

SUMMARY: This regulation establishes oxides of nitrogen (NO_x) emission standards for 1981 and 1982 model year light-duty vehicles belonging to certain diesel engine families for which I have granted waivers from the standard otherwise applicable under section 202(b)(6)(B) of the Clean Air Act, 42 U.S.C. 7521(b)(6)(B).

EFFECTIVE DATE: June 23, 1980.

ADDRESS: Information relevant to this rule is contained in Public Docket EN-80-3 at the Central Docket Section of the Environmental Protection Agency (EPA), Room 2903B, 401 M Street, S.W., Washington, D.C. 20460 and is available for review between the hours of 8:00 a.m. and 4:00 p.m. As provided in 40 CFR Part 2, EPA may charge a reasonable fee for copying services.

FOR FURTHER INFORMATION CONTACT: Jerry Schwartz, Manufacturers Operations Division (EN-340), U.S. Environmental Protection Agency, 401 M Street, S.W., Washington, D.C. 20460, (202) 472-9421.

SUPPLEMENTARY INFORMATION: Section 202(b)(1)(B) of the Clean Air Act ("the Act"), 42 U.S.C. 7521(b)(1)(B), requires that regulations applicable to NO_x emissions from light-duty vehicles or engines manufactured during or after the 1981 model year shall contain standards which provide that such emissions from vehicles or engines shall not exceed 1.0 gram per vehicle mile. Regulations implementing this requirement have established this NO_x standard.

Section 202(b)(6)(B) of the Act authorizes the Administrator, upon application by any manufacturer, to waive the statutory NO_x standard for the 1981 through 1984 model years for any light-duty diesel engine family for which the Administrator can make the required statutory findings. I must promulgate interim NO_x standards applicable to the subject light-duty diesel engine families for those model years for which I have granted waivers.

Volkswagen AG, and Automobiles Peugeot have submitted new applications for those waivers. The statutory criteria, my determinations with respect to the vehicle models covered by the waiver applications, and my decision to grant or deny the waiver applications appear in the consolidated decision published along with this notice. In that decision, I granted waivers covering the following engine families for 1981 and 1982 model years only:

Manufacturer and engine family	Model year
Peugeot: 2.3 Liter (L)-Turbocharged (TC)-XD2S..	1981, 1982
Volkswagen AG:	
1.6L naturally aspirated (NA), 2375 pounds inertia weight (I.W.)	1981, 1982
1.6L-NA-2500 I.W.	1981
2.0L-NA-3250 I.W.	1981, 1982
1.6L-TC-2375 I.W.	1982
1.6L-TC-2625 I.W.	1982
2.0L-TC-3250 I.W.	1982

Having decided to grant waiver applications for these diesel engine families, I am simultaneously promulgating regulations adopting emission standards not permitting NO_x emissions from 1981 and 1982 model year vehicles of these engine families to exceed the prescribed levels. The public has received an opportunity to comment on the waiver applications at issue, and I have considered those comments in making the consolidated decision which requires the promulgation of this rule. Also, the 1981 model year certification process is underway. For these reasons, I find that providing notice and an opportunity to comment on this rulemaking before final promulgation is impracticable and unnecessary.

Note.—The Environmental Protection Agency has determined that this action does not constitute a major proposal requiring preparation of a Regulatory Analysis under Executive Order 12044.

In addition, because the decision accompanying this rulemaking is based on a detailed analysis indicating that this rulemaking will have a negligible effect on air quality, the Environmental Protection Agency has not prepared an Environmental Impact Statement to accompany this rulemaking.

Dated: May 13, 1980.

Douglas M. Costle,

Administrator.

40 CFR Part 86 is amended as follows:

Subpart A—General Provisions for Emission Regulations for 1977 and Later Model Year New Light-Duty Vehicles, 1977 and Later Model Year New Light-Duty Trucks and 1977 and Later Model Year New Heavy-Duty Engines

40 CFR 86.081-8(a)(1)(iii) published at 45 FR 5480 (January 23, 1980), is revised to read as follows:

§ 86.081-8 Emissions standards for 1981 and later model year light-duty vehicles.

(a) * * *

(1) * * *

(iii) Oxides of nitrogen—1.0 grams per vehicle mile, except that: (A) Oxides of nitrogen emissions from 1981 and 1982 model year light-duty vehicles manufactured by American Motors Corporation shall not exceed 2.0 grams per vehicle mile; (B) oxides of nitrogen emissions from light-duty diesel vehicles of the following 1981 and 1982 model year engine families shall not exceed the prescribed levels:

Manufacturer and engine family	Model year	NO_x (gpm)
General Motors Corp.: 5.7 liter (L)....	1981, 1982	1.5
Daimler-Benz AG:		
2.4L	1981, 1982	1.5 1.25
3.0L naturally aspirated (NA).....	1981, 1982	1.5
3.0L turbocharged (TC)	1981, 1982	1.5
AB Volvo: 2.4L naturally aspirated....	1981, 1982	1.5

Manufacturer and engine family	Model year	Interim standard (gpm)
Peugeot: 2.3L-TC-XD2S.....	1981, 1982	1.5
Volkswagen AG:		
1.6L-NA-2375 pounds inertia weight (I.W.)	1981, 1982	1.3
1.6L-NA-2500 I.W	1981	1.4
2.0L-NA-3250 I.W	1981, 1982	1.5
1.6L-TC-2375 I.W.....	1982	1.3
1.6L-TC-2625 I.W.....	1982	1.4
2.0L-TC-3250 I.W.....	1982	1.5

(Secs. 202 and 301(a) of the Clean Air Act, as amended, 42 U.S.C. 7521, 7601(a)(Supp. I 1977))

[FR Doc. 80-15522 Filed 5-21-80; 8:45 am]

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ENVIRONMENTAL PROTECTION AGENCY

[FRL 1496-4]

Applications for Waiver of the 1981-85 Model Year Oxides of Nitrogen Emission Standard for Light-Duty Diesel Motor Vehicles—Second Consolidated Decision of the Administrator

I. Introduction

This is the second consolidated decision I have issued under section 202(b)(6)(B) of the Clean Air Act, as amended (Act)[1] regarding applications from automobile manufacturers for waiver of the 1.0 gram per mile (gpm) oxides of nitrogen (NO_x) emission standard scheduled to apply to 1981 and subsequent model year light-duty diesel vehicles and engines.[2]

As the introduction to the first diesel NO_x waiver decision explains, section 202(b)(1)(B) of the Act establishes the standards applicable to emissions of oxides of nitrogen (NO_x) from light-duty vehicles and engines manufactured during and after model year 1977.[3] This section requires the Administrator of the Environmental Protection Agency (EPA) to promulgate regulations containing standards which provide that NO_x emissions may not exceed 2.0 grams per vehicle mile (gpm) for model years 1977 through 1980, and may not exceed 1.0 gpm for 1981 and later model years.

Section 202(b)(6)(B) of the Act authorizes the Administrator to delay implementation of the 1.0 gpm NO_x standard by waiving it under certain conditions to permit the use of diesel engine technology. Section 202(b)(6)(B) of the Act provides that, upon the petition of a manufacturer, the Administrator may waive the 1.0 gpm NO_x standard to a level not to exceed 1.5 gpm, for any class or category of diesel-powered light-duty vehicles and engines manufactured during the four model year period beginning with model year 1981. In order to obtain a waiver, the manufacturer must show that the waiver is necessary to permit the use of diesel engine technology in the class or category of vehicles or engines for which it has requested a waiver. Moreover, the Administrator must determine:

(i) That such waiver will not endanger public health,

(ii) That such waiver will result in significant fuel savings at least equal to the fuel economy standard applicable in each year under the Energy Policy and Conservation Act ("EPCA"), and

(iii) That the technology has a potential for long-term air quality benefit and has the potential to meet or exceed the average fuel economy standard applicable under EPCA at the expiration of the waiver.[4]

On July 14, 1978, guidelines for the submission of applications under this waiver provision were published in the Federal Register.[5] The guidelines follow the language of the Act in placing an affirmative burden on the manufacturer to supply information sufficient to satisfy independently each of the waiver criteria set forth above for each engine family for which a waiver was requested. The guidelines also stress that although the waiver might be requested for the four model year period beginning with the 1981 model year up to a NO_x level of 1.5 gpm, the waiver could be granted for a shorter period of time and to an intermediate NO_x level between 1.0 and 1.5 gpm.

EPA held public hearings in response to an initial group of waiver applications, and on January 23, 1980, I published my consolidated decision on those applications. I granted the waiver applications covering certain engine familes which met all of the prescribed statutory criteria, and I denied the remaining applications on the basis that the applicants had submitted insufficient information to show the need for NO_x waivers to permit use of diesel engine technology in those engine families. Specifically, I denied Automobiles Peugeot's (Peugeot) request for waivers for two of its engine families and Volkswagen AG's (VW) request for three of its engine families because these manufacturers had failed to supply sufficient data by which I could assess adequately the respective NO_x emission control capabilities of their engine families. As a result, Peugeot and VW failed to show that waivers are necessary for any of these engine families, as the statute requires.[6]

Subsequent to my decision, I received reapplications from Peugeot and VW on February 6, 1980, and February 11, 1980, respectively. Specifically, Peugeot submitted a reapplication for four-year waivers for its diesel engine families while VW submitted a reapplication for two year waivers for its diesel engine families. Each of these reapplications included new emission data on each of the subject engine families. EPA held public hearings on these reapplications on February 27, 1980. The transcripts of these hearings, the materials submitted by the applicants in their original and follow-up waiver requests, and all other information upon which I have based my decision on this set of waiver requests are included in EPA Public Docket EN-80-3.

II. Summary of Decision

A. Waiver Applications Granted

The waiver applications which I have decided to grant cover the following engine families for the model years specified:

Waiver Applications Granted

Manufacturer	Model year	Engine family
Peugeot	1981, 1982	2.3 liter (L), turbocharged (TC)-XD2S.
VW	1981, 1982	1.6L naturally aspirated (NA), 2375 pounds inertia weight (I.W.).
	1981	1.6L-NA-2500 I.W.
	1981, 1982	2.0L-NA-3250 I.W.
	1982	1.6L-TC-2375 I.W.
	1982	1.6L-TC02625 I.W.
	1982	2.0L-TC-3250 I.W.

As discussed more fully below, I have concluded that applications covering these engine families meet each of the statutory criteria for receiving a waiver for the years noted. I am prescribing an interim NO_x standard of 1.5 gpm for Peugeot for these model years. For VW, I am prescribing the interim standards it proposed in its application, which are reproduced in the following chart:[7]

Engine family	Model year	Interim Standard (gpm)
1.6L-NA-2375 I.W.	1981, 1982	1.3
1.6L-NA-2500 I.W.	1981	1.4
2.0L-NA-3250 I.W.	1981, 1982	1.5
1.6L-TC-2375 I.W.	1982	1.3
1.6L-TC-2625 I.W.	1982	1.4
2.0L-TC-3250 I.W.	1982	1.5

B. Waiver Applications Denied

I am denying waiver requests covering the following engine families for the model years specified:

[1] 42 U.S.C. 7521(b)(6)(B) (Supp. I 1977).

[2] The first decision was published at 44 FR 5480 (January 23, 1980) (hereinafter "Orig. decision").

[3] 42 U.S.C. 7521(b)(1)(B) (Supp. I 1977). See the first diesel NO_x waiver decision for a discussion of the statutory history leading up to this provision. Orig. decision at 5480, n.1.

[4] For a discussion of the Congressional purpose behind this provision, see the discussion accompanying notes 2 and 3 of my original decision at 5480.

[5] 43 FR 30341 (July 14, 1978) (hereinafter "Guidelines").

[6] Orig. decision at 5487.

[7] Application for Waiver of Oxides of Nitrogen Emissions Standards for Light-Duty Engines submitted by Volkswagen AG, dated May, 1979 (hereinafter "Orig. VW App.") 2.-4.

Waiver Applications Denied

Manufacturer	Model year	Engine family
Peugeot	1983, 1984	2.3L-TC-XD2S, SC3S.

As I will discuss more fully below, I have concluded that the ever-accelerating development of NO_x control technology and a California production phase-in should provide sufficient experience for Peugeot to develop the technology necessary to enable the XD2S engine family to meet the 1.0 gpm NO_x standard by the 1983 model year. I have denied a waiver for the XD3S engine family because Peugeot submitted insufficient data by which I could adequately assess the NO_x emission control capabilities of this engine family.

III. Discussion

A. Assessing Need for Waivers

Section 202(b)(6)(B) of the Act expressly assigns to an applicant the burden of showing that the waiver is necessary to permit the use of diesel engine technology in a particular class or category of vehicles or engines. The major issue I must address under this criterion is whether the applicant has shown that unless I grant the waiver, the engine family which the waiver request covers will not be able to meet applicable emission standards, even with the addition of any device, equipment or aspect of diesel engine technology presently available or expected to become available during the period covered by the waiver request.[8]

1. *Decision Methodology*

The methodology this decision employs to assess an engine family's need for a waiver is the same as the methodology I used in my original diesel NO_x waiver decision.[9] Appendix A to this consolidated decision contains an assessment of technology available to meet the 1.0 gpm NO_x standard for each diesel engine family in question. The assessment is derived from a review of the diesel engine family as described in the waiver application and of each family after hypothethically factoring in one or more purposely conservative "Projected Technological Improvements" ("factors"). The methodology applies these factors for currently-known improvements and hardware that an applicant may implement during the waiver period (such as advanced EGR systems, compression ratio changes, or injection timing modifications.[10] Appendix A contains this evaluation for each engine family for which sufficient emission test data were available by using a "Monte Carlo" statistical simulation technique used in previous suspension and waiver decisions to project the likelihood that a given engine family will be able to pass EPA's certification test requirements under a 1.0 gpm NO_x standard.[11]

Appendix A also evaluates the effect of NO_x emission controls on emissions of particulate matter. This evaluation relies on information supplied by applicants in this proceeding and in the diesel particulate rulemaking proceedings,[12] as well as on other information contained in the record for this consolidated decision.

2. *Individual Applicants*

Each manufacturer has reached a state in its development of NO_x emission controls at which it has narrowed the range of strategies it contemplates employing to meet the 1.0 gpm NO_x standard and the particulate standard[13] to, at most, a few alternative systems. To support their contentions that waivers are necessary to permit the use of diesel technology for the engine families in question, both Peugeot and VW have provided descriptions of the systems each has been considering in efforts to meet 1981 and later model year emission standards.

(a) *Peugeot.* Peugeot reapplied for a waiver of the 1981–1984 NO_x standard applicable to its light-duty diesel vehicles. For the 1981 and 1982 model years, the waiver request applies to its XD2S engine family. For the 1983 and 1984 model years, the waiver request applies to the XD2S or the XD3S engine family.[14] I denied a waiver for these engine families in my first NO_x consolidated decision on the ground that Peugeot provided insufficient emission test data for evaluating the engine families' emission control capabilities.[15]

The reapplication provides additional emissions data and requests that I grant a waiver on the basis of Peugeot's assertions that it is unable to meet both the 1.0 gpm NO_x standard and the 0.6 gpm particulate standard that EPA had proposed at the time of Peugeot's application. Peugeot is relying totally on Exhaust Gas Recirculation (EGR) to lower its NO_x emissions.[16] EPA's analysis projects this engine family to be unable in the 1981 model year to meet the 1.0 gpm NO_x standard.[17]

EPA's analysis projects that vehicles in this engine family could certify at a 1.2 gpm NO_x standard without incorporating any available technological improvements, such as increased EGR rate.[18] Peugeot, however, asserted that this engine family needs a waiver of the NO_x standard to 1.5 gpm in order for Peugeot to have adequate confidence that production vehicles of this engine family wold meet applicable NO_x emission requirements.[19]

The data which Peugeot has submitted to support its position do not necessarily show that without a waiver up to 1.5 gpm this engine family will not be able to meet applicable NO_x emission requirements in production.[20] Nevertheless, because of Peugeot's

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[8] Guidelines, at 30342. Beginning in the 1981 model year, applicable statutory standards will be 0.41 gpm hydrocarbons (HC), 3.4 gpm carbon monoxide (CO), and 1.0 gpm NO_x. Beginning in the 1982 model year, the light-duty diesel vehicle particulate standard of 0.6 gpm takes effect. That standard becomes 0.2 gpm as of the 1985 model year. 45 FR 14496 (March 5, 1980).

[9] For a more complete discussion of the methodology employed see Orig. decision at 5484–5485.

[10] Appendix A, § IV.

[11] See Orig. decision at 5484 and discussion of Monte Carlo technique in the previous suspension decision published at 38 FR 10317, 10323 (April 26, 1973). EPA's certification test requirements are located at 40 CFR Part 86.

[12] EPA Public Docket No. OMSAPC–78–3.

[13] At the time of the applications, the proposed particulate standard for light-duty diesel vehicles was 0.6 gpm for the 1981 model year and 0.2 gpm for the 1983 and later model years. 44 FR 6650 (February 1, 1979). On February 21, 1980, I promulgated a final standard of 0.6 gpm for the model years 1982–1984 and 0.2 gpm for the 1985 model year and beyond. See 45 FR 14496 (March 5, 1980). The impact of this change on my evaluation of the manufacturers' data will be noted.

[14] Automobiles Peugeot Application for Waiver of the 1981–1984 NO_x Emission Standard, dated February 6, 1980 (hereinafter "P. App.") 1.–6. Peugeot indicated that its marketing plan for the 1983 and 1984 model years was uncertain and that it would actually market either the XD2S or the XD3S engine, or both. See Transcript of February 27, 1980 Public Hearing on the Waiver of the 1981–1984 Model Year Light-Duty Diesel NO_x Emissions Standard (hereinafter "Tr.") 55–56.

[15] Orig. decision at 5487.

[16] Until June, 1979 Peugeot's "first choice" system was its "advanced" hydraulic EGR system with a "mixed control unit". Peugeot stated that technical and mass production problems have necessitated a delay in applying that system, and it is uncertain whether this system will be available for 1982 model year California vehicles, although it is making a concerted effort to have the system ready at that time. Thus, an electropneumatic EGR system is the sole system available for 1981. The electropneumatic system is incapable of reaching the lower NO_x and particulate emission levels achieved by the "advanced" system. See P. App. 1–2, 2–1 and 2–3; and Tr. 11.

[17] Appendix A, Table II–1. This engine family did pass when the "factor" for the use of a fuel available in France but not in the United States was applied. See Appendix A, § IV.

[18] Appendix A, § V.

[19] See Letter from Richard H. Lucki, Government and Engineering Liaison (Peugeot) to Charles Freed, Director Manufacturers Operations Division (EPA), March 6, 1980 (Appendix 2) (hereinafter "Lucki Letter").

[20] For example, it is at least questionable that Peugeot will need to manufacture as much as 97.5% of its production vehicles to meet standards in order to satisfy Federal emission requirements pertaining to production vehicles. See Lucki Letter, p. 1.

expressed position, a significant risk does exist that, where I to set an interim standard less than 1.5 gpm, Peugeot would conclude that it needs to incorporate additional available technological improvements to reduce further this engine family's NO_x emission levels, and thereby provide what it deems to be adequate assurance that its certification and production vehicles will comply with any interim NO_x standard applicable in the 1981 model year.

The technological improvement which Peugeot would likely incorporate to accomplish this end would be use of an increased EGR rate.[21] While increasing the EGR rate tends to decrease NO_x emissions it also tends to place an upward pressure on particulate emissions.[22] As the public health discussion in Section III(B)(2) of this decision points out, I have concluded that increased particulate emissions pose potentially greater health risks than increased NO_x emissions. As a result, I am setting an interim NO_x standard of 1.5 gpm because available information shows that a significant risk exists that Peugeot needs the waiver to minimize the likelihood that it will increase its "base" EGR rates to meet any lower NO_x standard.[23]

With regard to the 1982 model year, Peugeot has also indicated its intent to use California as a proving ground for compliance with a 1.0 gpm NO_x standard.[24] Peugeot would then extend the technology of its 1982 California light-duty diesel vehicles to its 49-state models in the 1983 model year. I find that this phase-in period is necessary for Peugeot to identify and correct quality control problems that may arise with the application of the new control technology.[25]

b. *VW.* VW reapplied for a waiver of the 1981 and 1982 model year NO_x standards applicable to three classes of its light-duty diesel vehicles: Rabbit, Dasher and Audi 5000.[26] VW sought interim NO_x standards that decrease over time and vary for each vehicle class. The standards chosen reflect VW's assessment of the lowest NO_x levels it can achieve in each year in which it plans to produce a given class.[27] In its reapplication, VW split the vehicle classes for which it requested waivers in its original application into smaller classes according to method of aspiration, engine displacement, and vehicle model. VW's purpose in distinguishing among vehicle models was to show the best emissions control capability for the different inertia weight classes associated with each model, and to make it clear that VW believes that for these vehicles the higher inertia weight classes require a higher NO_x standard.[28] Therefore, in response to VW's request, and because it will result in increased emissions control, I have distinguished between VW's diesel classes on the basis of inertia weight for purposes of this consolidated decision. I denied waivers for these vehicles in my first consolidated NO_x waiver decision on the grounds that VW provided insufficient emission test data for evaluating the engine families' emission control capabilities.[29]

This reapplication provides new emission data and requests that I grant waivers on the basis of VW's assertions that 1) its diesel engine families planned for 1981 and/or 1982 cannot meet 1.0 gpm NO_x, 0.41 gpm HC, or both the statutory NO_x and HC standards and 2) the public health benefit resulting from decreasing particulates emissions if the waiver is granted for the remaining engine families, outweighs the possible danger resulting from the "additional" NO_x that would be emitted if the waiver is denied.[30]

My technical analysis of data submitted by VW showed the 1.6L–NA–2500 I.W. engine family to be incapable of meeting the 1981 NO_x standard.[31] It also showed the 1.6L–NA–2375 I.W. and 2.0L–NA—3250 I.W. engine families to be incapable of meeting both the NO_x standard and the HC standard of 0.41 gpm simultaneously in 1981.[32]

For the engine families VW plans to introduce in the 1982 model year, my analysis shows the 2.0L–TC–3250 I.W. engine family to be incapable of meeting the statutory 1.0 gpm NO_x standard in that year.[33] My analysis also shows that the 1.6L–TC–2625 I.W. engine family fails both the NO_x and the HC standard, as do the 1.6L–NA–2375 I.W. and 2.0L–NA–3250 I.W. engine families.[34] Finally, my analysis showed that the 1.6L–TC–2375 I.W. engine family was capable of passing the NO_x standard, but not capable of simultaneously passing the HC standard.[35]

In its waiver reapplication, VW indicated that in some instances these engine families were capable of meeting interim NO_x standards less than 1.5 gpm, and in fact requested waivers to those interim levels for the engine families in question.[36] EPA's analysis projects that these VW engine families will not be able to meet interim NO_x standards below these levels (and that VW's other diesel engine families will not be able to meet interim NO_x standards below 1.5 gpm).[37]

Because VW indicated that it did not need waivers of the NO_x standard to levels beyond those interim levels listed in its waiver reapplication, VW has not adequately shown that a significant risk exists that it will decide it needs to incorporate technological improvements (such as EGR) which may pose a health risk insofar as they affect emissions or unregulated pollutants to ensure that its

[21] Appendix A, § IV. When the factor for increased EGR was applied for the 2.3L–TC–XD2S engine family, a significant reduction in NO_x emissions was noted. This technological improvement is available for the 1981 model year.

[22] Appendix A, § IV. See also 45 FR 14496, 14498 (March 5, 1980). The technology-based particulate standard for light-duty diesel vehicles does not take effect until the 1982 model year.

[23] In *International Harvester Co.* v. *Ruckelshaus,* the Court instructed EPA in deciding on requests for delays in implementing scheduled emission standards to take into account the possibility of environmental harm that could result from failure to grant the requested delay. 478 F. 2d 615, 641 (D.C. Cir. 1974).

[24] P. App. 1–2.

[25] The California phase-in is necessary for Peugeot to mitigate the risks of national production, such as a recall of the national fleet, should it turn out that diesel vehicles with previously untried technology experience problems in complying with applicable emission standards in use. See discussion of the need for California phase-in in my original decision at 5485–5486. Peugeot has not shown here that the California phase-in opportunity will not give it adequate lead time to permit it to develop the technology needed to market this engine family nationally in the 1983 model year and the model years thereafter.

[26] Volkswagen Application for NO_x Waiver (hereinafter "VW App.") 1. VW indicated it would reasssess the need for a waiver for 1983 and 1984 and reapply for those years in the future if necessary.

[27] See table in section II.A. of this decision for the designated standards and model years of planned production.

[28] Tr. 65–66.

[29] In its original application, VW requested waivers for its 1.6 liter naturally-aspirated, 1.6 liter turbocharged, and 2.0 liter naturally-aspirated engine families. VW did not request a waiver for its 1.5 liter engine, although it did submit data for this engine family sufficient for EPA to make a technological assessment. The emission results of the 1.5 liter engine, however, could not be used as a substitute for 1.6 liter engine emission data as VW requested, because of the different technologies associated with each engine. Since VW submitted no durability data for the 1.6 liter turbocharged engine and submitted only low-mileage development vehicle data for the naturally-aspirated 1.6 liter engine, I classified both as "no-data" engine families. VW submitted no durability data for its 2.0 liter engines. See Appendix A—Summary of Technological Capability, Orig. decision at 5504.

[30] VW App. 4.

[31] Appendix A, Table II–2. Several engine families were projected to be capable of meeting the 1.0 NO_x standard with the catalyzed trap oxidizer factor applied. This technology, however, will not be available until after the 1982 model year. See Appendix A, § IV.

[32] Appendix A, Table II–2.

[33] Appendix A, Table II–2.

[34] Appendix A, Table II–2.

[35] Appendix A, Table II–2.

[36] VW App., Table I, p. 2. VW stated that it does not plan on using EGR on its 49-State vehicles to achieve its requested interim NO_x standards in 1981 and 1982. See Tr. 69.

[37] Appendix A, § V.

engine families will comply with its suggested interim NO_x levels.[38] As a result, I have determined that VW needs waivers of the statutory NO_x standard only to its requested interim levels for those engine families for which VW has suggested those levels, and to 1.5 gpm for its other diesel families.

VW indicated it would probably be able to market light-duty diesel vehicles in California in the 1982 model year, but only because of the benefit of the California HC evaporative emissions credit, a credit unavailable in the 49-state market.[39] VW also has the opportunity to use California as a "pilot market" in 1982 for Federal systems it will market in 1983.[40] This will enable VW to evaluate the data it receives from the California market, especially with respect to potential durability problems. Therefore, I have determined that effective emissions control technology is not available for these engine families for 1981 and 1982 to meet NO_x standards below the standards which VW suggested.

B. Endangerment to Public Health

In order to grant a waiver request, section 202(b)(6)(B)(i) requires me to determine that a waiver of the statutory standard of 1.0 gpm NO_x would not endanger the public health. Congress intended my assessment of this criterion to include consideration of the potential health effects of unregulated pollutants from diesel engines as well as the health effects associated with increased NO_x emissions.[41]

1. Oxides of Nitrogen (No_x)

a. *Air Quality Impact.* In my original decision, I concluded that the potential impact on ambient NO_x levels resulting from a NO_x waiver covering the engine families for which I granted a waiver would not be significant.[42] Granting waivers today for the engine families listed in section IIA will not alter this conclusion; that is, the potential impact on NO_x levels resulting from granting these additional waivers, even when combined with the impact from the waivers I granted earlier, will not be significant.[43]

b. *Public Health Impact.* In my original decision, I concluded that granting the waiver would have little impact on the projected annual decrease in ambient NO_x levels, and therefore granting those waivers would not endanger the public health.[44] Granting a waiver today for those engine families listed in section IIA will not alter that conclusion. Thus, I also conclude that today's waivers will not endanger the public health.

2. Particulates

My main health concern in these proceedings relating to emissions from diesel engines is over potential increased emissions of diesel particulates and focuses on the potential for an increase in the incidence of respiratory ailments, and the potential that organic components of the diesel particulates are carcinogenic.[45] These concerns warrant action, where appropriate, that would minimize particulate emissions from light-duty diesels.

a. *Air Quality Impact.* It is undisputed that the projected increase in diesel light-duty vehicle production will increase human exposure to respirable particulates.[46] This fact underscores my concern for action minimizing particulate emissions from light-duty diesels.

b. *Health Impact—i. Assessment of Risks—Granting or Denying Waivers.* In my original decision, I noted that to the extent that waivers are granted, the applicants will be able to market diesel vehicles that emit more particulates than would gasoline-powered vehicles. However, my assessment of the risk posed by these emissions must be made in light of the greater risk posed by the particulate emission levels that might result from waiver denial.[47]

If I deny a waiver, an applicant may choose not to manufacture the diesel engine family at all, or it may attempt to manufacture the diesels and successfully certify them in compliance with the 1.0 gpm NO_x standard. This is indeed a real possibility, not withstanding EPA's evaluation of the manufacturers' technological capabilities. EPA's Monte Carlo evaluation serves to quantify the risk that a given engine family will fail to comply with the standard in certification, and is purposely conservative in order to assure that an engine family classified in Appendix A as a "pass" would almost certainly pass certification requirements.[48] Thus, failing the Monte Carlo analysis does not indicate for certain that the engine family using currently-developed technology would not actually meet certification requirements under a 1.0 gpm NO_x standard, nor does it preclude the possibility of the manufacturer's making an all-out effort up until the start of the 1981 model year to develop calibrations which would permit successful certification of its diesel engine families.[49]

Peugeot stated that in 1979, 74% of Peugeot Motors of America's total sales

[38] Despite EPA's projection on the basis of available emission data, that these VW non-EGR engine families will not pass al certification requirements at the requested interim standards (Appendix A, § V), VW has nonetheless decided to attempt to successfully certify these engine families. This points out the conservative nature of the Monte Carlo analysis, and that a manufacturer might decide to go ahead with production despite EPA's projection that the manufacturer's vehicles will not pass all certification requirements.

[39] Tr. 71. California provides manufacturers with an evaporative emissions "credit" which results in a lower tailpipe HC standard for vehicles with low HC evaporative emissions (such as diesels). See California Exhaust Emission Standards and Test Procedures for 1981 and Subsequent Model Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles, as amended May 22, 1979, p.8.

[40] Tr. 71. As is the case for Peugeot, VW needs the California phase-in to mitigate the risks of national production, such as recall of the national fleet.

[41] See, e.g., H.R. Rep. No. 294, 95th Cong., 1st Sess. 19, 237, 250–51 (1977); S. Rep. No. 127, 95th Cong., 1st Sess. 70 (1977).

[42] Orig. decision at 5488–89.

[43] Appendix A, § VI.

[44] Orig. decision at 5489.

[45] Orig. decision at 5489. Although there is no current definitive epidemiologic evidence establishing cancer risk from exposure to diesel particulates, the uncertainty surrounding the potential health risk posed by diesel particulates warrants a cautious approach in regulating the vehicles which produce them. See discussion in Orig. decision at 5490.

[46] Diesel-powered vehicles emit particulates at a far greater rate than catalyst-equipped gasoline-powered vehicles. Orig. decision at 5489–5490.

[47] Orig. decision at 5490.

[48] The methodology provides a margin of error to provide manufacturers with a cushion for the risks of failing to comply with the emission requirements during actual certification testing and in production. This is necessary because the consequences of discovering at a later date that a manufacturer cannot comply after it makes development and production commitments could have serious economic consequences. See *International Harvester Co.* v. *Ruckelshaus*, 478 F. 2d 615, 630 (D.C. Cir. 1973).

[49] For a fuller discussion of the possibility that a manufacturer failing the Monte Carlo analysis would still produce diesel engine families under a 1.0 gpm NO_x standard see pages 5490–5492 of my original decision. Manufacturers have previously asserted that they were unable to produce the technology (Viz., catalytic converters) necessary to meet the 1975 model year statutory CO standard, and that a suspension was necessary to permit production. See Decision of the Administrator on Remand from the United States Court of Appeals for the District of Columbia Circuit, 38 FR 10317 (April 26, 1973). Even though EPA granted the requested suspensions, many manufacturers did produce 1975 model year vehicles employing catalysts.

Although waiver denial does not necessarily preclude the manufacturers from producing light-duty diesels, section 202(a)(4) of the Act does make specific provision for the assessment of health risks from emissions of unregulated pollutants associated with competing technologies. This section provides me with authority to deny certification to vehicles with technologies which "will cause or contribute to an unreasonable risk to public health, welfare or safety in its operation or function". (42 U.S.C. 7521(a)(4) (Supp. I 1977)). When the manufacturers apply for certification for the engine families at issue in this decision, I expect to be in a position to determine whether the vehicles presented for certification will pose an unreasonable risk to public health, welfare or safety.

in the U.S. were diesels.[50] Peugeot, therefore, has a strong incentive to attempt to certify and market its diesels even without a waiver. Peugeot might attempt to accomplish this by hastening the development of its "advanced" EGR system.[51] or by taking other actions that may require increased use of EGR. EPA's analysis of Peugeot's data for its XD2S engine family shows that increasing the use of EGR to reduce NO_x toward the statutory level of 1.0 gpm would place upward pressure on particulate emissions.[52]

By establishing a NO_x standard that Peugeot will be able to meet without using increased EGR for its diesel engine families, I can avoid giving rise to the risk that Peugeot will produce its diesel engine families under a 1.0 gpm NO_x standard with higher particulate emissions. Because increased particulates pose potentially greater health risks than increased NO_x, I conclude that granting waivers for Peugeot's diesel engine families, thereby precluding any need for the use of increased EGR systems that put upward pressure on particulates, is more protective of the public health than waiver denial.

The same reasoning is applicable to VW. VW indicated that without a waiver it would not be able to market diesel models in 1981.[53] It did admit, however, that simply because the data obtained from prototype vehicles of these models were above the engineering goals it would establish for a 1.0 gpm NO_x standard, did not necessarily mean it would not decide to mass produce these models. VW explained that the decision whether to produce or not is a management decision.[54] Depending on marketing and other factors, VW indicated its management might decide to accept the risk it perceived of committing its resources, without a waiver, to efforts to produce complying vehicles, even if the efforts might fail.

VW's management has significant incentives to make the decision to produce its diesel vehicles without a waiver. VW projects demand for diesels to be over 50% in some product lines.[55] VW indicated it seriously doubts whether it can maintain its sales volume without diesel models.[56] VW also stated that the continued viability of its Westmoreland, Pennsylvania plant would be threatened if it could not market diesels, because the plant cannot produce all gasoline-powered models.[57] Finally, VW would have to cancel its preliminary agreement with the state of Michigan for the construction of a new plant.[58] These facts suggests a strong possibility that VW may ultimately decide to produce diesel models without a waiver.

The engine families contained in VW's waiver request include some "concepts" that employ EGR and some that do not.[59] The most promising concepts in terms of NO_x emission reductions for model years 1981 and 1982, however, appear to be those employing EGR systems.[60] Use of this EGR technology will generally put upward pressure on particulate emissions.[61] Therefore, I conclude that granting VW's NO_x waiver requests also is more protective of the public health than waiver denial.

C. Fuel Economy

Fuel economy considerations are contained in the second and third criteria of section 202(b)(6)(B).[62] The second criterion provide that I may grant a waiver if I determine that it will result in significant fuel savings at least equal to the fuel economy standard applicable in each year under the EPCA.[63] To meet this criterion, the applicant must show that the "base level" for a class or category for which the applicant has requested a waiver will meet the applicable EPCA fuel economy standards.[64] The fuel economy standard for the 1981 model year is 22 miles per gallon (mpg) and the standard for the 1982 model year is 24 mpg.[65] All of the base levels of the engine families granted waivers in this decision will meet or better the fuel economy standards for 1981 and 1982 (the waiver years).[66]

The third criterion provides that I may grant a waiver if I determine, among other things, that the diesel engine technology has the potential to meet or exceed the average fuel economy standard applicable under EPCA at the expiration of the waiver. To meet this criterion, the applicant must show that there is a substantial likelihood that the average fuel economy of the applicant's diesel fleet will meet or exceed the EPCA standard.[67] The EPCA standard for 1983, the expiration year of the waivers, is 26 mpg.[68] I find that there is a substantial likelihood that the average fuel economy of the diesel fleets of the applicants will meet or exceed 26 mpg.[69]

D. Long-Term Air Quality Benefit

In order for me to grant a waiver. I must find that diesel engine technology has the potential for long-term air quality benefit.[70] The applicant will meet this criterion if there is a substantial likelihood that the engine families covered by its waiver request will be able to comply with the applicable emissions standards at the expiration of the waiver period.[71] The standards applicable at the expiration of the waiver period, model year 1983, are, in addition to the 1.0 NO_x standard, standards of 3.4 gpm for emissions of carbon monoxide (CO), 0.41 gpm for

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[50] Tr. 9.

[51] See P. App. 2–1 and 2–3 for discussion on Peugeot's differing EGR systems.

[52] Appendix A, § IV. As a result of my delaying the effective date of the light-duty diesel vehicle particulate standard until the 1982 model year, Peugeot could arguably increase the EGR rate in its 1981 model year diesel vehicles, thereby lowering the NO_x emissions from those vehicles below the 1.0 gpm standard, without concerning itself with violating any particulate standard. Moreover, the particulate standard I promulgated for the 1982 model year is a technology-based standard that reflects the greatest degree of particulate emission reduction achieveable through the application of technology which I have determined will be available for a given model year, considering lead time and other constraints. 42 U.S.C. 7521(a)(3)(A)(iii). An upward pressure on particulate emissions from increasing the EGR rate still could present a threat to the public health, even though the increase in particulate emissions would not cause Peugeot to be in violation of a particulate standard.

[53] Tr. 93.

[54] Tr. 80.

[55] Tr. 64.

[56] Tr. 94–95.

[57] Tr. 95.

[58] Tr. 92.

[59] VW App., 7–11.

[60] VW App., Table II, p. 5.

[61] In EPA's action promulgating light-duty diesel particulate standards, EPA noted that recognized deleterious effect of EGR on particulate emissions. 45 FR 14496, 14498 (March 5, 1980.)

[62] Clean Air Act, as amended, § 202(b)(6)(B) (ii) and (iii), 42 U.S.C. 7521(b)(6)(B) (ii) and (iii) (Supp. I 1977). a major consideration for Congress in providing for a waiver of the NO_x satandard for diesel-powered vehicles was the potential fuel economy benefits of diesel technology. See discussion accompanying footnote 3 of my original decision at 5480.

[63] Section 302(A)(i) of EPCA establishes fuel economy standards for 1978–80 and 1985 and thereafter and provides the Secretary of Transportation with the authority to promulgate standards for 1981–84. 15 U.S.C. 2002(a)(1)(1975).

[64] Guidelines, at 30343. Base level means "a unique combination of basic engine, inertia weight, and transmission class". 40 CFR 600.002–77(23) (1977).

[65] 49 CFR 531.5 (1978).

[66] Appendix A, § VI; P. App. 4–1, 4–1(a)(b); and Tr. 12–13. See discussion in my original decision at 5493.

[67] Average fuel economy means "the production-weighted combined fuel economy value of all passenger automobiles produced by a manufacturer in a single model year as computed in 40 CFR 600.510." 40 CFR 600.002–77 (14) (1977).

[68] 49 CFR 531.5 (1978).

[69] Appendix A, § VI. See also, Letter from W. Groth, Administrator, Emissions Regulations & Testing (VW) to Central Docket Section, Docket EN–80–3 (EPA) (March 4, 1980) (Attachment 3).

[70] 42 U.S.C. 7521(b)(6)(B)(iii) (Supp. I 1977).

[71] See 123 Cong. Rec. 13703 (Aug. 4, 1977) (remarks of Senator Muskie). See also 43 Fed. Reg. 30343, 30347 (July 14, 1978).

emissions of hydrocarbons (HC), and 0.6 gpm for emissions of particulates.[72]

1. *Peugeot*

I have already found that a small-scale phase-in of the technology necessary to meet a 1.0 gpm NO_x standard in California in model year 1982 will be necessary to permit Peugeot to avoid undue risks in nationwide production of the 49-state diesel fleet.[73] Peugeot has indicated that it could use the California market in 1982 in this manner.[74] The one-year California phase-in will provide Peugeot with an opportunity to develop reliable diesel emission control technologies necessary to meet a 1.0 gpm NO_x standard at lower particulate levels. Specifically, EPA's technical analysis indicates that Peugeot's hydraulic EGR system, coupled with some technology changes has the potential to achieve lower NO_x and particulate emission levels when fully developed.[75] Therefore, I find there is a substantial likelihood that Peugeot's engine family for which I am granting waivers today will be capable of meeting the Federal statutory standards in model year 1983.

2. *VW*

VW also has the opportunity to take advantage of California as a "pilot market" in 1982, for Federal production in 1983.[76] VW, however, is experiencing difficulties meeting a 0.41 gpm HC standard with some of its diesel engine families.[77] VW has stated that it intends to apply a catalytic converter to its California vehicles in 1982 to decrease HC emissions, and indicated it might meet all Federal standards in 1983 with its use, without an evaporative emissions credit.[78] Thus, I find there is a substantial likelihood that VW's engine families for which I am granting a waiver today will meet the Federal statutory standards in 1983.[79]

E. Final Decision and Amended Rule

Section 202(b)(6)(B) of the Act grants me the authority to waive the statutory standard of 1.0 gpm NO_x and to prescribe interim standards which provide that NO_x emissions may not exceed 1.5 gpm for any class or category of diesel light-duty vehicles or engines manufactured during model years 1981, 1982, 1983, and/or 1984 which meet the statutory waiver criteria. Based upon the foregoing discussion of the classes or categories for which waiver applications were made, I am granting waivers and simultaneously promulgating interim standards for engine families for model years 1981 and 1982 as follows:

Manufacturer and engine family	Model year	Interim standard (gpm)
Peugeot: 2.3L-TC-XD2S	1981, 1982	1.5
VW:		
1.6L-NA-2375 I.W	1981, 1982	1.5
1.6L-NA-2500 I.W	1981	1.4
2.0L-NA-3250 I.W	1981, 1982	1.5
1.6L-TC-2375 I.W	1982	1.3
1.6L-TC-2625 I.W	1982	1.4
2.0L-TC-3250 I.W	1982	1.5

Dated: May 13, 1980.

Douglas M. Costle,

Administrator.

Appendix A—Summary of Technological Capability

Contents

I. Introduction.
II. Summary of Technological Capability.
III. Statistical Treatment of the Data.
IV. Projected Technological Improvements (Factors).
V. Discussion of Individual Manufacturer's Technical Capability.
VI. Other Technological Considerations.
VII. References.

I. Introduction

The existing 1981 model year exhaust emission standards for light duty vehicles are 0.41 grams per mile HC, 3.4 grams per mile CO, and 1.0 grams per mile NO_x. Section 202(b)(6)(B) of the Clean Air Act, as amended, [42 U.S.C. 7521(b)(6)(B)] provides a waiver procedure by which a manufacturer may apply for relaxation of the 1.0 gram per mile NO_x standard up to 1.5 grams per mile for some period during model years 1981 through 1984 for Diesel-powered vehicles. Since the initial decision by the Administrator [1 at 5480]*, two vehicles manufacturers, Volkswagen and Peugeot, have resubmitted data for waiver consideration.

This appendix reviews the technological capability of the applicant manufacturers to meet the 1981 and subsequent model year NO_x standard of 1.0 grams per mile. The analysis contained in this appendix relies on analyses contained in previous technical appendices. These appendices are incorporated by reference [1 at 5494].

As required by Section 202(b)(6)(B), the technological feasibility evaluation performed by the technical staff is made to evaluate the technological capability of each applicant to achieve the 1.0 grams per mile NO_x emission standard, in order to determine whether or not a waiver is necessary to permit the use of Diesel engine technology.

II. Summary of Technological Capabilities

Tables II-1 and II-2 are the summaries of the two applicants' capabilities for achieving 0.41 HC, 3.4 CO, and 1.0 NO_x with the Diesel-powered vehicles for which data were submitted in the NO_x waiver re-applications.

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[72] 42 U.S.C. 7521(b)(1)(A), (B) (Supp. I 1977); and 45 FR 14496 (March 5, 1980).

[73] Orig. Decision at 5485.

[74] P. App. 1-2.

[75] Appendix A, § IV.

[76] See footnote 32.

[77] See, for example, VW APP., Table II, p. 4.

[78] Tr. 71-72.

[79] VW plans to introduce a "catalyzed" trap oxidizer that it expects will be ready for production sometime after model year 1982. This technology is designed to reduce particulates and HC simultaneously, thereby allowing greater EGR rates. See VW App. 14. Additionally, VW has only applied for waivers for a two-year period, and it has stated its intent to reapply for waivers for additional model years if it finds it is unable to meet the 1983 Federal standards.

* The brackets contain the description x at y. This means the referenced material is located in reference number x (listed at the end of this document) at page number y.

Table II-1

Applicant: Peugeot

[0.41 HC, 3.4 CO, 1.0 NOx]

Engine Family	No. of Vehicles (last 3 nos. of VIN)	W/O Factors: Vehicles P/F		W/O Factors: Reason for Failures			W/O Factors: Probability			Vehicle	Factor	W/Factors: Vehicles P/F		W/Factors: Reason for Failures			W/Factors: Probability		
		P	F	HC	CO	NOx	HC	CO	NOx			P	F	HC	CO	NOx	HC	CO	NOx
2.3L-TC (XD2S)	3 (516)		X	X		X	78	100	28	1	A		X	X			58	100	91
											B		X	X			30	96	83
											C		X	X	X		16	6	85
											D		X	X			58	100	91
											E		X	X		X	72	100	65
											F	X					96	100	83
	(909)*		X			X	87	100	63	2	A		X	X			72	100	94
											B		X	X			39	100	83
											C		X	X			18	100	85
											D		X	X			72	100	95
											E		X			X	80	100	77
											F	X					96	100	83
											Z		X			X	89	100	15
	(041)		X	X		X	69	100	32	3	A		X			X	96	100	0
											B		X	X		X	79	100	46
											C		X	X		X	76	100	76
											D		X			X	89	100	79
2.3L-TC (XD3S)	----------No data----------																		

*Official 1981 Certification vehicle

Table II-2

Applicant: Volkswagen*

[0.41 HC, 3.4 CO, 1.0 NOx]

		W/O Factors										W/Factors							
Engine Family	No. of Vehicles (last 3 nos. of VIN)	Vehicles P/F		Reason for Failures			Probability			Vehicle	Factor	Vehicles P/F		Reason for Failures			Probability		
		P	F	HC	CO	NOx	HC	CO	NOx			P	F	HC	CO	NOx	HC	CO	NOx
1.6L-NA-Rabbit	2 (522)		X	X		X	65	100	76	1	A		X	X			75	100	98
											B	X					95	100	100
	(845)		X	X		X	79	100	0	2	A		X			X	87	100	79
											B	X					98	100	100
1.6L-TC-Rabbit	2 (697)		X	X			45	100	86	1	A		X	X			61	100	98
											B	X					89	100	100
	(022)		X	X		X	47	100	0	2	A		X	X		X	58	100	75
											B	X					92	100	98
1.6L-NA-Dasher	1 (108)		X			X	91	100	0	1	A		X			X	93	100	0
											B		X			X	99	100	67
1.6L-TC-Dasher	1 (102)		X	X		X	47	100	0	1	A		X	X		X	64	100	30
											B	X					89	100	94
2.0L-NA-Audi	2 (863)		X	X		X	67	100	0	1	A		X	X		X	78	100	0
											B		X			X	92	100	0
											C		X	X			55	100	96
	(525)		X	X		X	58	100	0	2	A	X					93	100	97
											B			X		X	73	100	0
2.0L-TC-Audi	1 (610)		X			X	83	100	0	1	A		X			X	97	100	72
											B		X			X	85	100	0
											C		X	X	X		18	0	98

*Engine Family as Designated in Appendix

1.6L-NA-Rabbit
1.6L-TC-Rabbit
1.6L-NA-Dasher
1.6L-TC-Dasher
2.0L-NA-Audi
2.0L-TC-Audi

Engine Family as Designated in Decision

1.6L-NA-2375 IW
1.6L-TC-2375 IW
1.6L-NA-2500 IW
1.6L-TC-2625 IW
2.0L-NA-3250 IW
2.0L-TC-3250 IW

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The key to the summary tables is as follows. The first five column headings refer to analysis of the vehicles in an as-received condition; i.e., without any technological improvements applied to these vehicles. The first column heading lists the engine families. The second column heading is the number of vehicles in each engine family that were evaluated through the Monte Carlo analysis. [A detailed description of these vehicles is presented in Section V.] The third column heading is he number of vehicles that passed or failed the Monte Carlo analysis. The fourth column heading is the reason(s) for these failures, that is, which of the exhaust emissions were determined to have less than an 80 percent chance of certifying when it was evaluated by the Monte Carlo analysis. The fifth column heading is the probability of passing the particular standards as generated by the Monte Carlo analysis.

Column headings six through ten reflect the "technological improvements" applied to the as-received vehicles. Column heading six refers to the vehicles that were used for the Monte Carlo analysis. Column heading seven is a shorthand notation of the factors that were applied to the vehicles. This notation is further developed and explained in Section IV. Column heading eight refers to the number of vehicles again that passed or failed, this time with the improvements applied. Column heading nine is the reason for the failure, if the vehicle indeed failed, and whether it was a HC, CO, or NO_x failure. Column heading ten refers to the probabilites for compliance with the HC, CO, or NO_x standards that go along with the indication of a failure.

The "no data" category is an abbreviated notation for the lack of acceptable data to perform EPA's technological analysis. Applicants have, for several years, known the types of data necessary for EPA to make a determination whether or not a given vehicle would be projected to pass or fail a set of standards. Unfortunately, in many cases there were a lack of acceptable data for specific engine families. This effectively precluded EPA from making a pass/fail determination for those families. In these cases, the families are called no data and no pass/fail determination was made.

In the technological analysis, data from prior year's certification programs were not used. These data were not used because the technology and calibrations employed on these vehicles were not for may not be representative of the technology and calibrations that will be used for model year 1981. Vehicles designed and calibrated or much different, more lenient, emissions than those at issue here have little relevance to a forecast of technological availability.

III. Statistical Treatment of the Data

Again, no changes have been made in the basic Monte Carlo methodology since its last use in a technical appendix. This methodology has been discussed and used previously [1 at 5496]. There were no changes made to the variability inputs of the basic Monte Carlo methodology as a result of these re-applications [1 at 5496].

IV. Projected Technological Improvements (Factors)

The rationale for technological improvements (factors) is well discussed in previous technical appendices and will not be elaborated upon further [1 at 5496].

Unfortunately, the new data submitted did not allow the development of numerous technological improvements factors. For example, Peugeot provided limited development data, from which technological improvements are generated, for emission control systems other than their prime system. Volkswagen failed to provide development data for one engine family for which they are seeking a waiver.

Factor for EGR Settings (Rates) on the Peugeot Electropneumatic EGR System

Peugeot is planning to introduce an electropneumatic EGR system on their 2.3L turbocharged engine in model year 1981 [4 at 2–1]. Peugeot maintains that this system is sufficiently advanced to attain the model year 1981 calibrations necessary to complete the certification process by the start of production.

While the calibrations for model year 1981 may be fixed, according to Peugeot, Peugeot did present data which would allow the EPA technical staff to evaluate the effect of varying EGR rates on the electropneumatic EGR system. These data are presented in Table IV–1 [4 at 2.23–75/76]. In all cases the "setting" numbers in the table correspond to higher EGR rates.

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Table IV-1

Effects of EGR Settings (Rates) on the Peugeot Electropneumatic EGR System

VIN 2663022, 3500 IW, XD2S Engine, M4 [4 at 2.23-76]

HC	CO	NOx	Part	MPG	Remarks*
0.15	1.58	1.02	0.443	27.73	'81 setting
0.18	1.84	0.86	0.591	28.31	setting "No. 6"
(1.20)	(1.16)	(0.84)	(1.33)	(1.02)	(Factors)
0.15	1.58	1.02	0.443	27.73	'81 setting
0.25	3.12	0.78	0.95	27.67	setting "No. 2"
(1.67)	(1.97)	(0.76)	(2.14)	(1.00)	(Factors)

VIN 2769007, 3500 IW, XD2S Engine [4 at 2.23-75]

0.15	1.38	0.92	0.4151	31.73	'81 setting
0.23	2.23	0.84	0.5249	30.89	setting "No. 2"
(1.53)	(1.77)	(0.91)	(1.26)	(0.97)	(Factors)
0.15	1.38	0.92	0.4151	31.73	'81 setting
0.26	2.97	0.83	0.5785	30.79	setting "No. 3"
(1.73)	(2.15)	(0.90)	(1.39)	(0.97)	(Factors)

*From graphs at 2.23-75/76 1, 2, and 3, EGR settings "No. 6", "No. 2", and "No. 3" correspond to higher EGR rates than the base calibration.

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The effects of these higher EGR rates were to lower NO_x levels, raise HC and CO levels, and put upward pressure on particulates.

The factors for EGR setting corresponding to numbers 6, 2, and 3 were simulated in the Monte Carlo analysis of vehicles numbered 2867516 and 909. This factor was selected for simulation because: (1) this technology has a short lead time and could be implemented by 1981 model year introduction, (2) low cost, and (3) nominal impact on fuel economy.

Factors for Injection Timing Changes with the Peugeot Electropneumatic EGR Systems

Peugeot also supplied data which showed the effects of injection timing changes on the EGR system proposed for model year 1981. These data are shown in Table IV–2.

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Table IV-2

Effects of Injection Timing Changes on the Peugeot Electropneumatic EGR System

Timing 7° BTDC vs. '81 Calibration at 5° BTDC

	HC	CO	NOx	Part	MPG	Vehicle No.
	0.15	1.06	1.04	0.3125	26.35	3076549
	0.29	1.70	0.83	-	27.68	53ATA75
	0.32	2.27	0.90	0.4614	28.06	1001670
	0.14	1.30	1.06	0.3019	25.32	2867516
Avg. 7°	0.22	1.58	0.96	0.3586	26.85	
[4 at 2.23-79, 80, 81, and 84]						
	0.23	1.31	0.97	0.4929	28.23	2867516
	0.11	1.43	1.01	-	27.83	1002721
	0.39	2.52	0.75	0.4355	28.02	1001670
Avg. 5°	0.24	1.75	0.91	0.4642	28.02	
Factors	(1.08)	(1.11)	(0.95)	(1.29)	(1.04)	
Same Vehicle Comparison						
[4 at 2.23-81]						
	0.32	2.27	0.90	0.4614	28.06	7°
	0.39	2.52	0.75	0.4355	28.02	5°
Factor	(1.22)	(1.11)	(0.83)	(0.94)	(1.00)	
[4 at 2.23-84]						
	0.14	1.30	1.06	0.3019	25.32	7°
	0.23	1.31	0.97	0.4929	28.23	5°
Factor	(1.64)	(1.01)	(0.91)	(1.63)	(1.11)	

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It can be noted that while retarded injection timing has a positive effect on reduction of NO_x and fuel consumption, deleterious effects on HC, CO and in most cases particulate matter were observed. Since Peugeot is having difficulty in achieving NO_x and HC standards simultaneously, [4 at 2–12] the use of factors based on retarded injection timing may not help Peugeot achieve the emission levels necessary for 1.0 gram per mile NO_x.

These factors were also applied to vehicles 2867516 and 909 in the Monte Carlo simulation. Two factors were selected, one to represent an average reduction achievable with different vehicles, and one set of factors representative of what is achievable on one vehicle.

Peugeot presented data from vehicles equipped with their electropneumatic EGR system which could have provided factors for such things as the effect of transmission shift schedule, injector pump changes, time before initiation of EGR, EGR versus engine speed, and injector type. Generally, these technical changes produced little benefits towards reducing NO_x or particulate levels. Factors based on these changes were not pursued further since it is possible that these technical changes were incorporated into the model year 1981 calibration and little or no data were available to assess their effects on NO_x or particulate levels.

Effect of French Specification Fuel on the Peugeot Electropneumatic EGR System

Peugeot has long maintained that the quality of U.S. Diesel fuel has been detrimental to the ability of their engines to achieve HC and NO_x standards [4 at 2–12]. In Peugeot's additional data submission, they presented additional data which allowed the EPA technical staff to derive factors [8 at 2–23—31–1, 2]. These data are reproduced in Table IV–3. The factors generated indicate an improvement for all pollutants and a benefit on fuel economy. These factors were applied to all of the Peugeot vehicles analyzed in the Monte Carlo simulation.

Table IV-3

Effect of Fuel on the Peugeot Electropneumatic EGR System

U.S. Fuel	HC	CO	NOx	Part	MPG
	0.13	1.16	1.16	0.4283	26.62
	0.11	1.26	1.22	0.4763	26.13
Avg.	0.12	1.21	1.19	0.4523	26.38
[8 at 2-23 - 31-2]					
French fuel	0.09	0.69	1.06	0.3585	28.52
	0.09	0.96	1.09	0.3515	28.65
Avg.	0.09	0.84	1.08	0.3550	28.60
[8 at 2-23 - 31-1]					
Factors	(0.75)	(0.69)	(0.91)	(0.78)	(1.08)

While this technological improvement indicates a benefit in achieving emissions standards, the availability of higher quality fuel in the United States could be severely limited. Therefore, while the EPA technical staff concludes that French specification (improved quality) fuel could potentially allow Peugeot to achieve 1.0 gram per mile NO_x levels, the lack of this type of fuel on the U.S. market makes this approach unrealistic for the 1981 and 1982 model years. Peugeot supplied no information that would lead EPA to conclude that such fuel will be available throughout the U.S.

Factors for the Changes of EGR Rates on the Peugeot Hydraulic EGR System

Peugeot has been experimenting with an EGR system developed by the Robert Bosch Company that Peugeot has labeled the "hydraulic" as opposed to the "electropneumatic" system [4 at 2–8]. This system, even though Peugeot has started a durability vehicle with this system installed, will not be available before model year 1983 [4 at 2–1 and section 2.2.1.4]. Consequently, factors were developed to ascertain the viability of this technology for the post-1983 model year achievement of 1.0 gram per mile NO_x standards.

Table IV–4 shows the data which were used to develop the factors for judging the effects of EGR rates on the hydraulic EGR system. It is assumed that the 25% idle EGR rate would be Peugeot's preferred EGR setting. This is consistent with Peugeot's experience on the electropneumatic EGR system; i.e., as low an EGGR rate as possible to minimize particulate and HC problems. Note that the factors developed from vehicle 8000056 have a modest effect in reducing NO_x levels, but put upward pressure on particulates. However, the converse effect on particulates is true for the data from vehicle 8000004. Both of these factors were simulated on vehicle 041 in the Monte Carlo analysis.

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Table IV-4

Effects of EGR Settings (Rates) on the Peugeot Hydraulic EGR System

[4 at 2.23-77/78]

For Engine No. 8000056

	HC	CO	NOx	Part	MPG	Setting of Idle EGR
	0.28	2.98	0.72	1.042	26.12	35%
	0.19	2.96	0.81	1.433	26.34	30%
	0.21	2.58	0.83	1.009	25.71	30%
Avg.	0.20	2.77	0.82	1.221	26.03	
	0.23	2.46	0.86	0.8932	27.53	25%
	0.18	2.18	0.91	0.8617	25.96	25%
Avg.	0.21	2.32	0.89	0.8774	26.75	
Factors						
	(0.95)	(1.19)	(0.92)	(1.39)	(0.97)	30%/25%
	(1.33)	(1.28)	(0.81)	(1.19)	(0.98)	35%/25%

For Engine No. 8000004

	0.30	1.78	0.74	0.4081	29.69	35%
	0.21	1.69	0.79	0.3731	30.17	35%
Avg.	0.25	1.73	0.77	0.3906	29.93	
	0.19	1.83	0.84	0.3772	28.63	30%
	0.18	1.72	0.81	0.4112	29.30	25%
	0.24	1.68	0.90	.3836	29.29	25%
Avg.	0.21	1.70	0.86	0.3974	29.29	
Factors						
	(0.90)	(1.08)	(0.98)	(0.95)	(0.98)	30%/25%
	(1.19)	(1.01)	(0.90)	(0.98)	(1.02)	35%/25%

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Factor for Compression Ratio Changes on the Peugeot Hydraulic EGR System

The effects of compression ratio changes are observed in the data displayed in Table IV–5. These data indicate that compression ratio changes can have a beneficial effect on reducing either engine hydrocarbon or reducing NO_x emissions. Both sets of data indicate upward pressure on particulates. Again, factors for full time EGR were simulated in the Monte Carlo analysis of vehicle 041. This factor was selected because of its benefit for reduction of hydrocarbons and it would have less of an adverse impact on particulate levels. The EPA technical staff believes that the use of higher compression ratio coupled with EGR could have the potential to achieve both NO_x levels below 1.0 gram per mile and particulate levels below 0.6 gram per mile. However, lead time precludes the use of this system before model year 1983.

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Table IV-5

Effect of Compression Ratio on the Peugeot Hydraulic EGR System

[4 at 2.23-90] VIN 042, M4, XD2S-TC Engine

	HC	CO	NOx	Part	MPG	Remarks
	0.22	1.56	1.12	0.4344	28.98	12° Timing, 30% EGR,
	0.17	1.46	1.03	0.3034	29.25	No EGR before 120 sec.
	0.20	1.51	1.10	0.3689	29.12	CR 21.59
	0.34	1.75	0.94	0.5900	29.26	Same as above except
	0.14	1.74	0.99	0.5710	30.27	CR 22.56
	0.24	1.75	0.97	0.5835	29.77	
Factor $\frac{\text{CR 22.56}}{\text{CR 21.59}}$	(1.20)	(1.16)	(0.88)	(1.58)	(1.02)	
[4 at 2.23-91]						
	0.49	1.93	0.63	0.4294	27.02	10° Timing, 30% EGR,
	0.36	1.90	0.65	0.3480	28.07	CR 21.54
	0.43	1.92	0.64	0.3887	27.55	
	0.20	1.72	0.79	0.5580	28.04	Same as above except
	0.24	1.99	0.80	0.5373	27.84	CR 22.56
	0.22	1.86	0.80	0.5476	27.94	
Factors $\frac{\text{CR 22.56}}{\text{CR 21.54}}$	(0.51)	(0.97)	(1.25)	(1.41)	(1.01)	

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Factors for the Effect of Injection Timing Change and Injection Timing Changes Without EGR for the First 160 Seconds of Vehicle Operation on the Peugeot Hydraulic EGR System

Tables IV–6 and 7 illustrate the effects of injection timing retardation on the hydraulic EGR system. These factors were developed but *not* used in the Monte Carlo simulation. They are included here as illustrations of the potential for achieving both a NO_x *and* particulate reduction simultaneously by use of the hydraulic EGR system and injection timing retarded. There is a penalty for hydrocarbons and fuel economy, however. These timing changes, possibly coupled with the aforementioned technologies, indicate that there is a potential for the hydraulic EGR system to achieve lower NO_x and particulate levels when fully developed.

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Table IV-6

Influence of Injecton Timing on the Peugeot Hydraulic EGR System

[4 at 2.23-86] Vehicle 042 "Permanent" EGR - 30% EGR

	HC	CO	NOx	Part	MPG_u	Timing
	0.19	1.83	0.84	0.3772	28.63	12°
	0.34	1.61	0.81	0.3260	27.02	10°
	0.49	1.93	0.63	0.4294	27.02	10°
	0.36	1.90	0.64	0.3480	28.07	10°
	0.40	1.81	0.69	0.3678	27.77	
	0.91	2.19	0.72	0.3975	29.13	8°
	0.65	1.95	0.62	0.3573	27.79	8°
	0.78	2.07	0.67	0.3774	28.46	
Factors						
10°/12°	(2.11)	(0.99)	(0.82)	(0.98)	(0.97)	
8°/12°	(4.11)	(1.13)	(0.80)	(1.00)	(0.99)	

[4 at 2.23-88] Vehicle 012 "Permanent" EGR - 30% EGR

	0.20	1.64	0.81	0.8595	24.45	10°
	0.22	2.18	0.88	0.8580	23.55	10°
	0.21	1.91	0.85	0.8588	24.00	
	0.32	1.63	0.87	0.5613	22.89	8°
	0.37	2.06	0.79	0.4145	23.69	6°
	0.51	2.00	0.76	0.4312	23.09	6°
	0.44	2.03	0.78	0.4228	23.39	
Factors						
8°/10°	(1.52)	(0.85)	(1.02)	(0.66)	(0.95)	
6°/10°	(2.10)	(1.06)	(0.92)	(0.49)	(0.97)	
6°/ 8°	(1.38)	(1.25)	(0.90)	(0.75)	(1.02)	

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Table IV-7

Effect of Injection Timing on the Peugeot Hydraulic EGR System Calibration for No EGR in the First 160 Seconds of Vehicle Operation

	HC	CO	NOx	Part	MPG	Timing
	0.22	1.85	1.00	0.6935	22.38	10°
	0.21	1.83	0.92	0.7686	23.09	10°
	0.21	1.84	0.96	0.7310	22.73	
	0.23	1.52	0.87	0.5621	23.33	8°
	0.44	2.07	0.80	0.4736	22.68	6°
Factors						
8°/10°	(1.10)	(0.83)	(0.91)	(0.77)	(1.03)	
6°/10°	(2.10)	(1.13)	(0.83)	(0.65)	(1.00)	

[4 at 2.23-89]

Technology Improvements (Factors) for Volkswagen Engines

Volkswagen has applied for NO_x waivers for six engine families in the latest submission for a NO_x waiver [5 at 2]. Unfortunately, Volkswagen did not provide detailed technical development data for their 1.6L naturally aspirated or turbocharged engines from which the EPA technical staff could develop technological improvement factors. Of the data supplied [References 2, 3 and 5], the EPA technical staff was able to extract a set of factors for a combustion chamber ratio change, a long lead time item, and to extrapolate the results from the 2.0L engine equipped with a catalytic converter or trap oxidizer. Again, these data would indicate the potential for this technology, but Volkswagen maintains this is a long lead time item not ready before 1982 [5 at 7] or 1985 [5 at 11]. Also, the EPA technical staff would prefer not to translate technology between engine families which are family specific, but the paucity of 1.6L engine family data necessitates this transfer.

Volkswagen did submit data which indicated the effects of injection timing, injector nozzle modifications, and EGR in their initial application [3 at Table 1]. However, the injection timing modifications and nozzle modifications are now incorporated into 1981 model year vehicles and these two factors are no longer applicable. The EPA technical staff did evaluate the effects of EGR on the 2.0L engines. Additionally, Volkswagen evaluated concepts employing EGR for all of their available engine families for 1981 and 1982. Table IV-9 will detail the factors applicable to a non-modified 1979 engine. Volkswagen provided, for simulation only, one durability vehicle which did not incorporate the injection timing changes and injector nozzle modifications [5 at 59].

Volkswagen affirmed there were no additional 1.6L development vehicle data available for analysis [6 at 88].

Volkswagen Combustion Chamber Ratio Change Factor

A technology evaluated by VW was to change the prechamber volume to main combustion chamber volume in an attempt to reduce NO_x emissions. A comparison was made to ascertain the effect of this change, the data being presented in Table IV-8 [2 at 2.b.1-51].

While this type of change may be a long lead time item if retooling heads, patterns, and casting changes are needed, these factors were simulated in the Monte Carlo analysis to see if they affected VW's ability to pass. These factors were applied to all 1.6L engines, either NA or TC.

Table IV-8

Volkswagen Combustion Chamber Ratio Change Factor

Engine Family/Vehicle	HC	CO	NOx	Part	Remarks
4 cyl., 1.6L,	0.35	1.32	1.21	0.32	No. 14
2250 IW, M4	0.31	1.33	0.98	-	No. 17 (low cc ratio)
Factors	(0.88)	(1.01)	(0.81)	-	

Volkswagen EGR and Increased EGR Factors for the 2.0L–NA Engine

The data analyzed for these factors are detailed in Table IV–9. The factors of interest are those for low rate EGR (Cond. 3 versus Cond. 2), and for high rate EGR (Cond. 4 versus Cond. 2). It should be noted there is a dramatic reduction in NO_x for these factors, but a severe penalty for HC, particulates, and fuel economy with greater amounts of EGR.

For those engines not equipped with concept 1, injection timing and injector nozzle modifications (VIN 148–809), the factor of interest in Table IV–9 is condition 3 versus condition 1. These factors were applied to the Volkswagen 2.0L durability vehicles.

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Table IV-9

Audi 5000 EGR Evaluation, 2.0L-NA M4, 3250 IW

Vehicle No. 847-521 [5 at 41]

Cond.	Test	HC	CO	NOx	Part	FE	Comments
1	1	0.291	1.125	1.467	0.53	26.6	1979 Prod.
	2	0.447	1.372	1.502	0.49	24.6	vehicle as
	3	0.351	1.400	1.534	0.58	26.2	received
	Avg.	0.363	1.299	1.501	0.53	25.8	
2	1	0.254	1.231	1.371	0.32	29.6	With modified
	2	0.232	1.164	1.282	0.39	29.0	injection curve
	3	0.219	1.307	1.328	0.38	28.7	+ reduced nozzle
	Avg.	0.235	1.234	1.327	0.36	29.1	tolerance
3	1	0.439	1.871	1.057	0.50	26.7	With modified
	2	0.478	1.936	0.909	0.48	26.7	injection curve
	3	0.372	1.812	0.953	0.40	25.8	+ reduced nozzle
	4	0.408	1.899	0.912	0.46	26.7	tolerance and
	Avg.	0.424	1.879	0.957	0.46	26.5	EGR (low rate)
4	1	0.602	2.486	0.726	0.56	27.1	With modified
	2	0.762	2.530	0.638	0.62	27.2	injection curve
	Avg.	0.682	2.508	0.682	0.59	27.1	+ reduced nozzle tolerance and EGR (high rate)

Factors

Cond. 2/Cond. 1	(0.65)	(0.95)	(0.88)	(0.68)	(1.13)
Cond. 3/Cond. 1	(1.17)	(1.45)	(0.64)	(0.86)	(1.03)
Cond. 4/Cond. 1	(1.88)	(1.93)	(0.46)	(1.11)	(1.05)
Cond. 3/Cond. 2	(1.80)	(1.52)	(0.72)	(1.27)	(0.91)
Cond. 4/Cond. 2	(2.90)	(2.03)	(0.51)	(1.63)	(0.93)

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Volkswagen Trap Oxidizer Factor

Volkswagen provided the data displayed in the upper portion of Table IV-10 as representative of the results to date with a trap oxidizer applied to a vehicle equipped with EGR. Volkswagen maintains that this concept is no longer viable because of its adverse effects on NO_x levels (5 at 14). This technology was simulated on all 2.0L engines to ascertain the HC/NO_x reduction potential of this technology as the technology does provide a particulate reduction benefit.

Table IV-10

Volkswagen

Trap Oxidizer and Catalyzed Trap Oxidizer Factors

Trap Oxidizer VIN 503-611, 2.0L-NA, 3250 IW, M4 [5 at 44]

	HC	CO	NOx	Part	MPG	Remarks
	0.413	1.985	1.300	0.54	28.6	Baseline
	0.377	2.033	1.390	0.42	27.5	w/Trap Oxidizer
Factors	(0.91)	(1.02)	(1.07)	(0.78)	(0.96)	

Catalyzed Trap Oxidizer VIN 490-667, 2.0L-NA, 3250 IW, M5 [5 at 46]

	0.461	1.914	1.832	0.69	27.3	Baseline
	0.231	0.216	1.130	0.42	27.8	w/Catalyst Trap Oxidizer
Factors	(0.50)	(0.11)	(0.62)	(0.61)	(1.02)	

Volkswagen Catalyzed Trap Oxidizer Factor

The lower portion of Table IV–10 contains the data for the factors attributable to the technology Volkswagen feels will solve tneir emissions problems when fully developed [5 at 14]. As the data show, this technology has the ability to simultaneously reduce HC, CO, NO_x and particulate levels without adversely affecting fuel economy. The reduction in NO_x levels may be attributable to the fact this technology allows the use of more EGR than would be allowed without it. Volkswagen commented there were driveability problems with the use of the technology which will have to be overcome [5 at 14].

Volkswagen maintains trap oxidizer technology is a long lead time technology not available until the 1985 period [5 at 17, 18]. The EPA technical staff does not necessarily agree with Volkswagen's time schedule of 1985 because of the background experience that could allow transfer of similar technology developed for gasoline powered vehicle catalyst systems, but they agree it would take at least through model year 1982 to complete development of the Volkswagen concepts.

These factors were simulated on all 1.6L and 2.0L engines in the Monte Carlo analysis. While the use of these factors may not be appropriate for the 1.6L engines because they were developed on a 2.0L engine, the EPA technical staff used them to assess the potential for this technology in the post 1982 time frame [6 at 76].

Volkswagen 2.0L–TC No EGR to EGR Factor

One of the durability vehicles submitted was equipped with injection timing and injector nozzle modifications, but no EGR. To assess the effects of the addition of EGR to this vehicle, the factors in Table IV–11 were developed. These factors were only applied to vehicle VIN 503–610. This factor also has an adverse effect on HC, CO and particulates.

Table IV-11

Volkswagen 2.0L-TC No EGR to EGR Factor

VIN 490-674, 2.0L-TC, 3250 IW, M5 [5 at 42]

	HC	CO	NOx	Part	MPG	Remarks
	0.313	1.407	1.496	-	-	Baseline, 2.0L-TC engine, 4K miles [5 at 39]
	0.291	1.125	1.467	0.42	26.6	Timing and nozzle mods
	0.212	0.891	1.563	0.39	27.3	
Avg.	0.251	1.008	1.515	0.41	26.9	
	0.443	4.522	0.755	0.61	26.7	Same as above + EGR
Factors $\left(\frac{\text{No EGR}}{\text{EGR}}\right)$	(1.76)	(4.49)	(0.50)	(1.49)	(0.99)	

Summary of Factors Applied in Monte Carlo Simulation

The factors applied to the vehicles simulated in the Monte Carlo analysis are all listed in Table IV-12.

Table IV-12

Factors Used in the Monte Carlo Simulation

Mfg.	VIN-Monte Carlo	Letter Code	Factors HC	CO	NOx	Remarks
Peugeot 2.3L-TC	2867516	A	1.20	1.16	0.84	EGR Setting #6
		B	1.53	1.72	0.91	" " #2
		C	1.73	2.15	0.90	" " #3
		D	1.22	1.11	0.83	2° Timing Change (Diff. Vehs.)
		E	1.08	1.11	0.95	" " " (Same Vehs.)
		F	0.75	0.69	0.91	French fuel vs. U.S. fuel
	909	A	1.20	1.16	0.84	EGR Setting #6
		B	1.53	1.72	0.91	" " #2
		C	1.73	2.15	0.90	" " #3
		D	1.22	1.11	0.83	2° Timing Change (Diff. Vehs.)
		E	1.08	1.11	0.95	" " " (Same Vehs.)
		F	0.75	0.69	0.91	French fuel vs. U.S. fuel
		Z	1.00	1.00	1.00	w/o particulate tunnel
	041	A	0.51	0.97	1.25	CR Change
		B	0.90	1.08	0.98	30% EGR vs. 25% EGR
		C	0.95	1.19	0.92	" " " " " (Diff. Eng.)
		D	0.75	0.69	0.91	French fuel vs. U.S. fuel
Volkswagen Rabbit 1.6L-NA	449-522	A	0.88	1.01	0.81	Comb Chamber Change
		B	0.50	0.11	0.62	Catalyzed Trap Oxid.
	449-845	A	0.88	1.01	0.81	Comb Chamber Change
		B	0.50	0.11	0.62	Catalyzed Trap Oxid.
Rabbit 1.6L-TC	449-697	A	0.88	1.01	0.81	Comb Chamber Change
		B	0.50	0.11	0.62	Catalyzed Trap Oxid.
	463-022	A	0.88	1.01	0.81	Comb Chamger Change
		B	0.50	0.11	0.62	Catalyzed Trap Oxid.
Dasher 1.6L-NA	476-108	A	0.88	1.01	0.81	Comb Chamber Change
		B	0.50	0.11	0.62	Catalyzed Trap Oxid.
Dasher 1.6L-TC	455-102	A	0.88	1.01	0.81	Comb Chamger Change
		B	0.50	0.11	0.62	Catalyzed Trap Oxid.
Audi 2.0L-NA	148-809	A	0.50	0.11	0.62	Catalyst Trap Oxid.
		B	0.91	1.02	1.07	Trap Oxidizer
		C	1.17	1.45	0.64	No EGR — EGR
	847-525	A	0.50	0.11	0.62	Catalyst Trap Oxid.
		B	0.91	1.02	1.07	Trap Oxidizer
Audi 2.0L-TC	503-610	A	0.50	0.11	0.62	Catalyst Trap Oxid.
		B	0.91	1.02	1.07	Trap Oxidizer
		C	1.76	4.49	0.50	No EGR — EGR

V. Discussion of Individual Manufacturer's Technical Capability

Once more, as in the previous analysis, this section discusses all the vehicles which, (1) were submitted by both of the applicants, and (2) were also acceptable for input into the Monte Carlo simulation. Additionally, acceptability for input means, (1) that the vehicle is a durability vehicle which has accumulated a minimum of 20,000 miles with the same major emission control components, and (2) that a minimum of four valid 1975 FTP tests have been conducted on the vehicle.

A discussion of the pass/fail determinations noted in Section II are also presented in this section. To pass the 1981 emission standards of 0.41 HC, 3.4 CO, 1.0 NO_x, the probabilities of passing each individual pollutant must be greater than or equal to 80%. If the probability of passing HC, for example, is less than or equal to 79%, the vehicle fails—even if the probabilities for CO and NO_x greatly exceed the 80% cutpoint.

Pass/fail analysis is provided only for emission standards for 0.41 HC, 3.4 CO, and 1.5 NO_x. The complete data needed for a similar analysis in emission standards of 0.41 HC, 3.4 CO, and 1.0 NO_x are presented in the Monte Carlo outputs. An analysis of a NO_x standard between 1.0 gpm and 1.5 gpm are included in the discussion of the vehicles entered into the Monte Carlo simulation where appropriate.

Peugeot

The durability vehicles contained in the Peugeot NO_x waiver applications [4 at 23.1–7/8, 23.1–9/10] which met the minimum criteria for entry into the Monte Carlo simulation are shown in Table V–1. It will be noted that a model year 1981 Certification durability vehicle has also been simulated in the Monte Carlo analysis. The reasons for the use of this vehicle in the simulation were; 1) sufficient time has passed since the first waiver application that model year 1981 certification durability vehicles, equipped with technologies targeted to achieve 1.0 gram per mile NO_x levels, are now actively being tested, and 2) the results of the certification vehicle analysis were used only for comparison with the results obtained from the technical analysis conducted for the noncertification vehicles.

Table V-1

Vehicles in Peugeot Motors Waiver Application
Meeting the Minimum Criteria for Entry into Monte Carlo

Engine Family	VIN	Control System	Entered into M.C.	If not-Why not
2.3L-TC (XD2S)	286516	Electropneumatic EGR	Yes	
	041	Hydraulic EGR	Yes	
	909*	Electropneumatic EGR	Yes	
XD3S		- No data supplied -		

*Official Model Year 1981 Certification vehicle.

Pass/Fail Analysis for 2.3L–TC Engines

Both non-certification prototype vehicles which were powered by the 2.3L–TC engine, *failed* the Monte Carlo analysis at 1.0 gram per mile NO_x levels with and without factors. Refer to Table II–1 for the probabilities of passing at 1.0 gram per mile NO_x levels.

A discussion of the vehicles follow. Vehicle 2867516, equipped with a turbocharger and an electropneumatic EGR system, was unable to achieve the 1.0 gram per mile NO_x levels either without factors or when simulated with the factors discussed previously. Vehicle VIN 041, equipped with a turbocharger and hydraulic EGR system (a post-1982 system) also failed with and without factors.

The Monte Carlo analyses at interim NO_x levels were reviewed, and they revealed that vehicle VIN 2867516 could certify to a 1.2 gram per mile NO_x level *without* application of factors. However, supplemental durability data submitted by Peugeot has caused the Monte Carlo analysis now to project that this vehicle will *fail* the HC standard of 0.41 grams per mile [8 at 22.3–8]. Previously, the original data submitted by Peugeot displayed a probability of 87% passing at 0.41 HC for this vehicle. These data are shown in Table V–2.

Table V–2.—*Monte Carlo Simulation Probability of Passing Interim NO_x Levels for Vehicle VIN 2867516—Without Factors*

	Probabilities (percent)		
NO_x level	HC	CO	NO_x
1.0	78	100	28
1.1	78	100	75
1.2	78	100	92
1.3	78	100	97
1.4	78	100	100
1.5	78	100	100

As a check on the prototype vehicle, the Monte Carlo simulation of the 1981 model year Certification vehicle, VIN 909, indicated that vehicle could certify to 1.1 grams per mile NO_x with an 87% probability of achieving the 0.41 HC standard at all NO_x levels. This simulation is shown in Table V–3.

Table V–3.—*Monte Carlo Simulation Probability of Passing Interim NO_x Levels for Vehicle VIN 909—Without Factors*

	Probabilities (percent)		
NO_x level	HC	CO	NO_x
1.0	87	100	63
1.1	87	100	[illegible]
1.2	87	100	99
1.3	87	100	[illegible]
1.4	87	100	100
1.5	87	100	100

In the post-hearing data submission by Peugeot, it was revealed that vehicle VIN 909 had been durability emission tested both under the 1981 test procedures and with the 1982 test procedures which call for the use of the particulate tunnel [8 at 2–23—6–2]. The above data were generated with the particulate tunnel in operation. The EPA technical staff analyzed the data without the tunnel and the results are to be found in Table V–4. The vehicle data used for these simulations are found in Table V–5.

Table V–4—*Monte Carlo Simulation Probability of Passing Interim NO_x Levels for Vehicle VIN 909—Without Factors—Without Particulate Tunnel*

	Probabilities (percent)		
NO_x level	HC	CO	NO_x
1.0	89	100	15
1.1	89	100	65
1.2	89	100	91
1.3	89	100	98
1.4	89	100	100
1.5	89	100	100

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Table V-5

Effects of a Particulate Tunnel on Gaseous Emission from a XD2S Powered Peugeot Vehicle

Vehicle VIN 909, 505 Sedan, 3500 #IW, A3, Electropneumatic EGR, MY81 Calibrations, Official EPA Durability Vehicle

Mileage		HC		CO		NOx		Particulate		MPG	
/Part. unnel	WO/Part. Tunnel	W/Part. Tunnel	WO/Part. Tunnel	W/Part. Tunnel	WO/Part. Tunnel	W/Part. Tunnel	WO/Part. Tunnel	W/Part. Tunnel	WO/Part. Tunnel	W/Part. Tunnel	WO/Part. Tunnel
4982	4962	0.245	0.242	0.99	1.56	1.02	0.94	0.439	-	24.50	24.87
0002	9991	0.267	0.240	1.10	1.10	0.99	0.97	0.407	-	24.51	24.35
5017	14998	0.291	0.242	1.31	1.62	0.95	1.04	0.510	-	24.91	24.60
5035	15056	0.324	0.194	1.31	1.34	0.97	0.96	0.449	-	24.80	24.80
0021	20041	0.157	0.205	1.03	1.08	1.07	1.03	0.446	-	24.20	24.03
5041	25064	0.148	0.185	0.96	1.07	1.07	1.03	0.428	-	23.93	24.63
9935	29953	0.151	0.142	0.85	0.92	1.08	1.06	0.334	-	24.16	24.69
9973	29991	0.244	0.202	0.99	0.95	1.01	1.08	0.441	-	24.31	24.02
5085	25104	0.140	0.192	0.97	1.04	0.96	0.97	0.397	-	24.94	24.82
9954	39973	0.146	0.201	0.86	1.07	0.94	1.03	0.311	-	24.54	25.22
4000		0.28	0.22	1.19	1.46	1.01	0.96				
50000		0.09	0.16	0.80	0.76	0.99	1.07				
DF		0.32	0.71	0.67	0.52	0.98	1.11				

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What these simulations in the preceding tables project is that the 2.3L–TC engine family could certify to 1.2 grams per mile NO_x without additional technological improvements.

A check was made on particulate levels for both of these engines, and Peugeot reports both of the vehicles are exhibiting particulate levels below 0.6 grams per mile. The particulate levels range from .28 to .44 grams per mile for vehicle 2867516 and .33 to .51 grams per mile for vehicle 909.

Pass/Fail Analysis XD3S Engine Family

Peugeot provided no durability data for this engine family. It is considered a no data family.

Analysis of Volkswagen Engine Families

All of the durability vehicles submitted by Volkswagen were acceptable for Monte Carlo simulation and were so simulated. Table IV–12 identifies these vehicles.

It should be further noted that Volkswagen has asked for different interim NO_x levels for an engine family (1.6L–NA and TC), depending on the vehicle model. Table V–6 outlines these requested NO_x levels [5 at 2]. While this is a deviation from present EPA certification practices i.e., the largest sales, inertia weight model, is usually selected to simulate the emission levels from an engine family marketed in different models (body styles), this split does not pose a problem for Monte Carlo simulation. Consequently, the pass/fail analysis will be discussed as per the Volkswagen waiver request.

Table V–6

Volkswagen Interim NOx Levels

Disp. (Liter)	Method of aspiration	Models	1980 Eng. Fam. Designation	Volkswagen Proposed NOx Std. 1981 (g/mile)	1982
1.6	N.A.	Rabbit Jetta	D	1.3	1.3
1.6	N.A.	Dasher Audi 4000	D	1.4	-
2.0	N.A.	Audi 5000	D–A	1.5	1.5
1.6	T.C.	Rabbit Jetta	(new)	-	1.3
1.6	T.C.	Dasher Audi 4000	(new)	-	1.4
2.0	T.C.	Audi 5000	(new)	-	1.5

[5 at 2]

Pass/Fail Analysis 1.6L–NA Rabbit Engine Family

Two vehicles were submitted for Monte Carlo simulation of this engine family. Both of these vehicles failed the Monte Carlo analysis at the 1.0 gram per mile NO_x level. Both of the vehilces passed the 1.0 gram per mile NO_x level with factors applied. The factors applied are the long lead time factors of combustion chamber change and catalyzed trap oxidizer. No data was submitted for this engine family to allow the EPA technical staff to analyze the effects of factors for EGR or increased EGR on particulate emissions. Therefore, the EPA technical staff considers this engine family to have *failed* at 1.0 gram per mile NO_x levels for model years 1981 and 1982 both with and without factors. There are however, interim NO_x levels that these vehicles pass. The discussion of these vehicles follows.

Vehicle VIN 449–522 fails the Monte Carlo analysis at all NO_x levels above 1.0 gram per mile because of a *hydrocarbon* pass rate of only 65 percent.

As mentioned previously, the use of a catalyzed trap oxidizer would improve the hydrocarbon pass rate while allowing a simultaneous NO_x pass probability. This technological improvement was simulated for this vehicle and resulted in a pass at 1.0 gram per mile NO_x. However, the trap oxidizer technology will not be available before 1983. Therefore, the EPA technical staff concludes that this vehicle could pass at an interim NO_x level 1.1 gram per mile *provided* Volkswagen could control the hydrocarbon emissions. When questioned about control of hydrocarbon emissions, Volkswagen stated they would indeed achieve the statutory hydrocarbon levels if they were granted the interim NO_x levels they requested [6 at 83]. The EPA technical staff does not contest Volkswagen's affirmation that they can achieve the statutory HC and CO standards. The EPA technical staff concludes that the statutory HC and CO standards will be met at the interim NO_x level of 1.3 grams per mile based on the conservative Monte Carlo analysis and Volkswagen apparent willingness to proceed with certification.

The possibility that Volkswagen can meet the statutory HC and CO standard at 1.3 gram per mile NO_x is at least corroborated by the second vehicle, VIN 449–845 which gives the following probabilities for HC, CO and NO_x at the 1.3 gram per mile NO_x level, 79, 100, 90. These levels are achieved without application of factors. The *hydrocarbon* pass rate is below the necessary 80% probability, as projected by the Monte Carlo analysis, but because of the conservative nature of the analysis, Volkswagen's contention that it will achieve all statutory emissions levels if granted a NO_x waiver of 1.3 grams per mile is not contradicted.

Therefore, on the basis of Volkswagen's request, an interim NO_x standard of 1.3 grams per mile for the 1.6L–NA Rabbit engine family for model years 1981 and 1982 is appropriate. This timeframe will allow the applicant to benefit from the California experience [1 at 5485] and to complete the development of the catalyzed trap oxidizer.

Pass/Fail Analysis of the 2.6L–TC Rabbit Engine Family

Volkswagen has requested the same interim NO_x standard, 1.3 grams per mile, for this engine as for the 1.6L–NA version. The only difference is they want that standard for model year 1982 only. As shown in Table II–2, the simulated vehicles failed at the 1.0 gram per mile NO_x levels without factors, but passes at 1.0 gram per mile NO_x levels with the catalyzed trap oxidizer factor. The results of the 1.6L–TC Rabbit engine family Monte Carlo simulation are analogous to the 1.6L–NA Rabbit engine family results. The individual vehicle results are discussed.

Vehicle VIN 449–697 was found to have the following HC, CO and NO_x probabilities of passing at 1.3 gram per mile NO_x levels: 45, 100, 99. Again, there appears to be a problem with *hydrocarbons* at this NO_x level.

The second vehicle, VIN 463–022, has NO_x passing probabilities of 47, 100, 81 at 1.3 grams per mile. Here, also, a situation similar to the 1.6L–NA Rabbit engine family exists. Again, because of the conservative nature of the Monte Carlo analysis, the manufacturer's contention that they will achieve the statutory emission levels for HC and CO at the 1.3 gram per mile NO_x level, is not contradicted, and an interim standard of 1.3 grams per mile is appropriate in 1982.

Pass/Fail Analysis 1.6L–NA Dasher Engine Family

Volkswagen has requested an interim 1.4 gram per mile NO_x level for this engine family for one model year only (1981). The one vehicle, VIN 476–108, simulated in the Monte Carlo analysis indicates that this engine family will fail at the 1.0 gram per mile NO_x level with or without factors. The Monte Carlo simulation indicates that this vehicle will achieve an interim NO_x level of 1.4 grams per mile NO_x with the factor for change in combustion chamber ratio, and 1.1 gram per mile NO_x with the catalyzed trap oxidizer factor. As both of these factors represent long lead items, the conservative Monte Carlo analysis would *not* predict that the 1.4 gram per mile interim NO_x levels proposed by Volkswagen could be achieved by 2981. However, the EPA technical staff concludes nevertheless that the 1.4 gram per mile interim NO_x level would be appropriate for this engine family.

Pass/Fail Analysis 1.6L–TC Dasher Engine Family

The situation analagous to the Rabbit engine family also exists for this engine family. The Monte Carlo simulation predicts that his engine family would fail at 1.0 gram per mile NO_x without factors and pass 1.0 gram per mile NO_x with the catalyzed trap factor. The Monte Carlo simulation also indicates the probability of passing 1.4 gram per mile NO_x levels are 45, 100, 100 without factors. Again, *hydrocarbons* are the problem and consequently, the EPA technical staff recommends an interim 1.4 gram per NO_x standard for this engine family.

Pass/Fail Analysis for 2.0L–NA Audi Engine Family

As the data in Table II–2 shows, the two vehicles simulated without factors fail at the 1.0 gram per mile NO_x standard. One vehicle passed at 1.0 gram per mile NO_x with the factor for the catalyzed trap oxidizer. One vehicle, 148–809, achieves, without factors, the 1.5 gram per mile NO_x level but fails *hydrocarbons*. The other vehicle, 847–525, achieves without factors, the 1.4 gram per mile NO_x level but also is predicted to fail *hydrocarbon* levels.

Therefore, the EPA technical staff concludes that of all the vehicles simulated, these two require the use of a catalyzed trap oxidizer and EGR to achieve NO_x levels below 1.5 gram per mile NO_x. As trap oxidizer technology is not available until post model year 1982, the technical staff concludes that 1.5 gram per mile NO_x is the only achievable NO_x level before 1983 for this engine family. The simulation of the technological factors of No EGR to EGR and increased EGR on EGR equipped vehicles also placed upward pressure on particulates for this engine family.

Pass/Fail Analysis for 2.0L–TC Audi Engine Family

Table II–2 indicates that the vehicle simulated in the Monte Carlo analysis failed both with and without factors at the 1.0 gram per mile NO_x standard. With the factor for EGR applied, a reduction in NO_x emissions was noted but with a penalty for particulate emissions. The technical staff concludes that this engine family will not be able to achieve NO_x emissions levels below 1.5 gram per mile NO_x in model year 1982.

The EPA technical staff concludes that 1.5 gram per mile will be the lowest NO_x levels achievable in 1982 for this engine family.

VI. Other Technological Considerations

Fuel Economy

Fuel economy is a criterion which the Administrator must consider in his decision to grant or deny the applicants, NO_x waiver request. The two issues of importance are individual engine family fuel economy results or projections and fleet sales weighted average fuel economy effects.

Individual Engine Family Fuel Economy Results

Only those engine families for which an emission control capability analysis was conducted are considered in this section. Data displayed in Section IV show that those engine families which were analyzed comply with the required fuel economy standards of 22 MPG and 24 MPG in 1981 and 1982 respectively. The data given in Section IV are Urban fuel economy values; and the "composite" fuel economy levels will be higher than the Urban fuel economy levels shown. Therefore, the engine families considered should have no difficulty achieving the fuel economy standards.

Fleet Sales Weighted Average Fuel Economy Effects

The applicants provided no new data upon which to make projections for the time period of interest, 1981–82. Therefore, the analysis prescribed in the first remains unchanged [1 at 5505].

Post-Waiver Period Issues

Two post-waiver period issues, long-term air quality benefits and fuel economy potential, were discussed in detail in the last NO_x waiver decision [1 at 5506]. The present applications provided no new data to modify the previously articulated conclusions.

Air Quality Summary

The two applicants provided no new information other than their previously supplied air quality analyses for the first NO_x waiver applications. Therefore, the conclusions reached in the first NO_x waiver decision remain unchanged [1 at 5507 thru 5511].

VII. References

1. Federal Register, Vol. 45, No. 16, Wednesday, January 23, 1980, Notices.

2. Application for Waiver of the 1981–1984 NO_x Emission Standards for light duty engines submitted to the Environmental Protection Agency by Volkswagen AG, May, 1979.

3. Volkswagen of America, Inc.—additional information for NO_x Waiver Hearings official records—dated July 13, 1979 from Mr. W. Groth (VW) to Mr. B. Jackson (MSED).

4. *Automobiles Peugeot,* Application for Waiver of the 1981–1984 NO_x Emission Standard, dated February 6, 1980.

5. Volkswagen Application for NO_x Waiver, dated February 20, 1980.

6. Transcript of Proceedings, United States Environmental Protection Agency, In the Matter of: Public Hearing on the Waiver of the 1981–1984 Model Year Light-Duty Diesel NO_x Emissions Standard, Washington, D.C., February 27, 1980, Acme Reporting Company.

7. Volkswagen of America Inc.—additional information for NO_x Waiver Hearings official records—dated March 4, 1980, from W. Groth (VWA) to EPA, Central Docket Section.

8. U.S. Technical Research Co., Automobiles Peugeot—additional information for NO_x Waiver Hearings official records—dated March 6, 1980—from R. H. Lucki (Peugeot) to C. Freed (EPA).

9. Volkswagen of America Inc.—additional information for NO_x Waiver Hearings official records—dated March, 1980—from W. Groth (VWA) to EPA, Central Docket Section.

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